the ENERGY lab

PROJECT FACTS

Advanced Research

High-Temperature Nano-Derived Micro-Hydrogen and -Hydrogen Sulfide Sensors

Background

The Department of Energy (DOE) National Energy Technology Laboratory (NETL) seeks applications for the University Coal Research (UCR) Program to further develop the understanding of coal utilization. Since the program's inception in 1979, its primary objectives have been to (1) improve our understanding of the chemical and physical processes involved in the conversion and utilization of coal in an environmentally acceptable manner; (2) maintain and upgrade the coal research capabilities and facilities of U.S. colleges and universities; and (3) support the education of students in the area of coal science.

The proposed project directly supports the energy initiative of the state of West Virginia and West Virginia University (WVU), which centers on research that targets the use of coal to produce energy with low environmental impact and low carbon emissions. Researchers at WVU, in collaboration with NexTech Materials, Ltd. (NexTech) will develop micro-scale chemical sensors and sensor arrays composed of nano-derived metal-oxide composite materials to detect hydrogen (H_2) and hydrogen sulfide (H_2S) within high-temperature environments (500–1200 degrees Celsius (°C)). The chemical sensors will then be used for emission monitoring in future power generation systems.

Project Description

Currently, micro-patterned semi-conductor based chemical sensors are created using thin film deposition and wet/dry etching processes. This project will demonstrate an innovative microcasting process for forming chemiresistive sensors with 20–100 micrometer feature size of various geometries composed of nano-composite electrodes that display high-temperature microstructural and morphological stability. In order to achieve this goal, the work will concurrently address issues relating to electrode stability, selectivity, and sensor miniaturization.

Goals/Objectives

The project goal is to develop micro-scale chemical sensors and sensor arrays to detect gases such as H_2 and H_2S within high-temperature environments. The project directly aligns with the long-term goal of the Advanced Research Program to demonstrate sensor materials and processing strategies that can also be used on sensor arrays that monitor other chemicals.

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PARTNERS

NexTech Materials, Ltd.

PROJECT DURATION

Start Date
07/08/2010

End Date
12/31/2013

COST

Total Project Value
$299,950

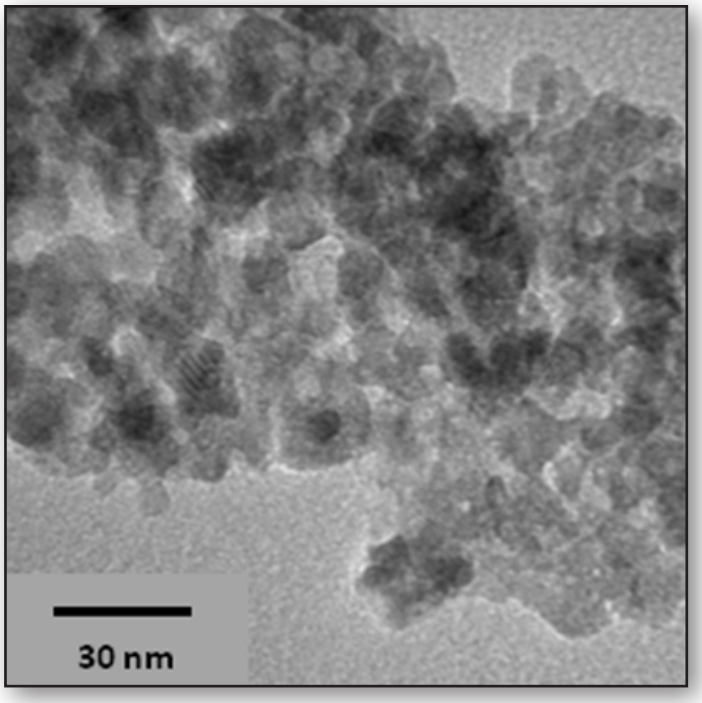
DOE/Non-DOE Share
$299,950 / $0

To achieve this goal, the project will complete the following objectives:

- Investigate methods for stabilizing the microstructure of nano-composite H_2 and H_2S selective electrodes for high-temperature chemiresistive sensing applications.
- Investigate the effect of sensor electrode poisoning due to typical impurities in coal syngas at high temperature.
- Define a lost-mold microcasting process to produce micron-scale three-dimensional sensor structures (with feature sizes less than 100 micrometers) composed of nano-composite selective electrode nanopowders.
- Demonstrate and test H_2 and H_2S micro-sensor arrays utilizing the nano-composite selective electrode materials.

Benefits

The performance of advanced power systems is limited by the lack of sensors and controls capable of withstanding high-temperature and high-pressure conditions. Harsh environments are inherent to new systems that aim to achieve high efficiency with low emissions. In addition, these systems are complex, with operational constraints and system integration challenges that push the limits of traditional process controls. Chemiresistive electrode sensors such as those being developed in this project will be able to withstand the high temperatures and pressures present in power generation systems; concurrently address issues relating to electrode stability, selectivity, and sensor miniaturization; and represent the next step in monitoring and control technology.



TEM micrograph of refractory nanomaterials (<10nm in size) for H_2 and H_2S sensing at temperatures >500°C

Source: Edward Sabolsky